Task 7: Documentation of Sensory Deficiencies in the Operation of Unmanned Aircraft Systems (Williams)

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Task Stakeholders/Sponsors
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University/Contract Performing Organization:
NA

Project Start Date: 10/1/2007 **Anticipated End Date:** 9/30/2010

Requirements Statement
Operational Shortfall or Knowledge Gap Unmanned Aircraft Systems (UAS) pilots do not have the same amount and types of sensory information available to them as pilots in the aircraft. An assessment is needed of how these sensory deficiencies might affect the safety of UAS flights.
Benefit in Closing the Shortfall or Gap An understanding of how sensory deficiencies affect UAS pilots will allow establishment of standards and guidelines for control station design and UAS pilot training that will maintain the safe operation of these aircraft when they are introduced more fully into the National Airspace System (NAS).
Description of the Desired Product The product from this research will be recommendations for standards and guidelines for control station design and UAS pilot training.
Schedule This research is scheduled to continue through the end of FY 2010.

Research Objective
Assess the operating environment of manned and unmanned aircraft to understand sensory cues available to each and remedial actions necessary to safely operate within the expected range of unmanned flight. Assess the degree to which existing unmanned aircraft systems have remedied the impact of the unavailability of sensory cues. Assess the degree to which training for unmanned operations has compensated for the general lack of sensory cues. Develop guidance for certification and qualification for unmanned operations to ensure operators have adequate information to rapidly identify and correct anomalies during UA flights.

Background
Unmanned aircraft are those without an onboard pilot. The military has used unmanned aircraft for several decades with various levels of success and more recently there has been an increase in demand for non-military unmanned aircraft operations. Within the last few years, commercial unmanned aircraft operations have concentrated on surveillance and advertisement, but several companies have expressed an interest in using unmanned aircraft for a range of other operations. Aviation analysts state that unmanned aircraft operations will transform the aviation industry and the recent proliferation of requests to use unmanned aircraft in the national airspace is not a fad. Although, unmanned aircraft refers to pilot-out-of-the-aircraft operation, a human operator is still a critical element in the success of an unmanned aircraft operation. Not surprisingly, the largest contributing factor for unmanned aircraft mishaps is human error (Draper, Calhoun, Ruff, Fontejon, and

Guilfoos, July 16, 2003, Multi-sensory interface concepts and advanced visualization techniques for UAV systems, presented at the Association for Unmanned Vehicle Systems International Conference, Baltimore, MD). To achieve the Federal Aviation Administration's Flight Plan, Increased Safety Goal: Objective 2 - reduce the number of fatal accidents in general aviation, Strategy - establish standard procedures and guidelines for general aviation operators, Initiative - develop policies, procedures, and approval processes to enable operation of unmanned aircraft systems, the UAS Program Office needs human factors guidance to assist in decisions regarding the operation of these aircraft, specifically, the interface available to the pilot, and how this interface affects the efficiency and safety of the flight. Research may investigate the effects of pilot performance by different types of interfaces; how a lack of certain types of sensory cues can affect the ability of the pilot to become aware of and react to various types of anomalous events, and how training should be structured to account for the lack of sensory cues and the specific flight interface being used.

Previous Activity on this Task

Work completed to date has included: 1) an analysis of manned aircraft sensory information; 2) a comparison of manned sensory information to sensory information available to the unmanned aircraft pilot; 3) a review of remediations for sensory deficiencies from the current UAS inventory; 4) a review of human factors research related to enhancing sensory information available to the UAS pilot; and 5) a review of current FAA regulations related to sensory information requirements.

CAMI personnel explored the use of simulation for the purpose of conducting an empirical study in support of resolving human factors issues related to sensory deficiencies experienced by UAS pilots. In addition, CAMI personnel participated in working groups involved in the development of guidelines and standards for UAS control stations.

Proposed or Planned Research

The research proposed for FY09 consists of consolidating the analyses and recommendations from FY08 and incorporating those recommendations in the work of several standards working groups. These working groups include at least the following:

- RTCA Special Committee 203
- SAE-G10 working group on unmanned aircraft system training guidelines
- FAA – EUROCONTROL Memorandum of Cooperation (MoC), Annex 4, Action Plan 24 Working Group for Unmanned Aircraft Systems
- Current NAS operations, including police department operation in Miami, FL and Houston, TX, and border patrol operations in Sierra Vista, AZ.

Other working groups may be added at the discretion of the principal investigator, with a consensus from the UAS program office. In addition, an empirical investigation will be undertaken to look at one or more research issues identified in FY08 and summarized in the technical report created from that activity. In addition, an empirical investigation will be undertaken to compare the effectiveness of multiple sensory cues on pilot awareness of flight parameters (i.e., heading, altitude, airspeed) and the ability to identify anomalous aircraft states such as an engine out or a landing gear failure. The results from the investigation will be summarized in a technical report.

Research Question(s)

1. Analysis of Manned Aircraft:
    - What "naturally sensed" information (i.e., cues obtained directly through human senses) is available to pilots for detecting unsafe conditions? Are any of these cues addressed by FAA regulations?
    - What "artificially sensed" information (i.e., electrical sensors, displays/alerts) is available to pilots for detecting unsafe conditions? Are these required by FAA regulations?
    - How is naturally- and artificially-sensed information used *procedurally* (e.g., checklists, crew coordination) for detecting unsafe conditions? Are these required by FAA regulations?
    - How is naturally- and artificially-sensed information used by pilots as part of *training/certification*, for detecting unsafe conditions?

2. Theoretical Limitations in UAS Sensing
   - What are the theoretical safety consequences of a pilot's ability to detect unsafe conditions?
   - Consider various manned aircraft sensors/alerts/displays, procedures, pilot training/certification.
3. Theoretical Remediations for UAS Sensing
   - What are the possible UAS remediations that can be used to compensate for a lack of naturally-sensed information?
   - Consider UA sensors, control station alerts/displays, crew procedures and pilot supervision, crew training/certification).
   - Consider changes to current manned aircraft policy and regulations
4. Examples of Remediations from Current UAS Inventory
   - What remediations have been undertaken by the UAS manufacturer to accommodate the detection of unsafe conditions?
   - Consider UA sensors, control station alerts/displays, crew procedures and pilot supervision, crew training/certification).

Technical Approach

Current Year

CAMI personnel will continue to develop simulation resources for the purpose of conducting an empirical study in support of resolving human factors issues related to sensory deficiencies experienced by UAS pilots. In addition, CAMI personnel will participate in working groups involved in the development of guidelines and standards for UAS control stations.

An empirical study will be conducted to further explore the concepts identified in the previous work on UAS pilot sensory deficiencies (Williams, 2008). The study will compare different information and formats on pilot awareness of flight parameters and system/environmental anomalies (non-normal conditions). Software development will be required to allow the creation of a UAS control station interface. Aircraft alerts will be presented through visual and/or auditory modes. The pilot will be required to maintain an awareness of certain information during a simulated flight and will need to respond to an anomalous event (e.g., landing gear failure) in a timely manner, for example, by initiating a go-around procedure. The simulation capability created for this research should provide enough flexibility to allow future research on human factors issues related to UAS control station design. The result of the empirical research will be summarized in a technical report to the sponsoring organization. The report will note potential gaps and vulnerabilities in UAS control station design and suggest possible design and training remediations.

Out-Years

NA

Air Traffic Resources Required

None

Information Technology Resources Required

Assist with unmanned simulation capabilities; subject contract

Calibration

None

FY10 Milestone Schedule		
Description	Proposed Start Date	Proposed Completion Date
Perform site visits to NAS operations	FY10 Q1	FY10 Q1
Establish UAS simulation capability	FY09 Q1	FY10 Q2
Conduct empirical study of sensory information	FY10 Q3	FY10 Q4
Participate in standards workgroups	FY08 Q4	FY10 Q4

FY10 Deliverables		
Description	Proposed completion date	Actual completion date
Technical report summarizing empirical research findings	FY10 Q4	